Aerosol Particle Density Determination Using Light Scattering in Conjunction with Mass Spectrometry

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Features of the LS-AMS

- All particles that impact the vaporizer surface (d_p > 180 nm), first pass through the laser beam and scatter light – providing per particle measurements of scattered light (R_{LS}), vacuum aerodynamic diameter (d_{va}) and chemical ion signal (R_{MS}). (Panel 1 and 2)

- Correlated R_{LS} (optical) and R_{MS} (chemical) measurements provide an in situ measurement of the collection efficiency of the AMS. (Panel 2)

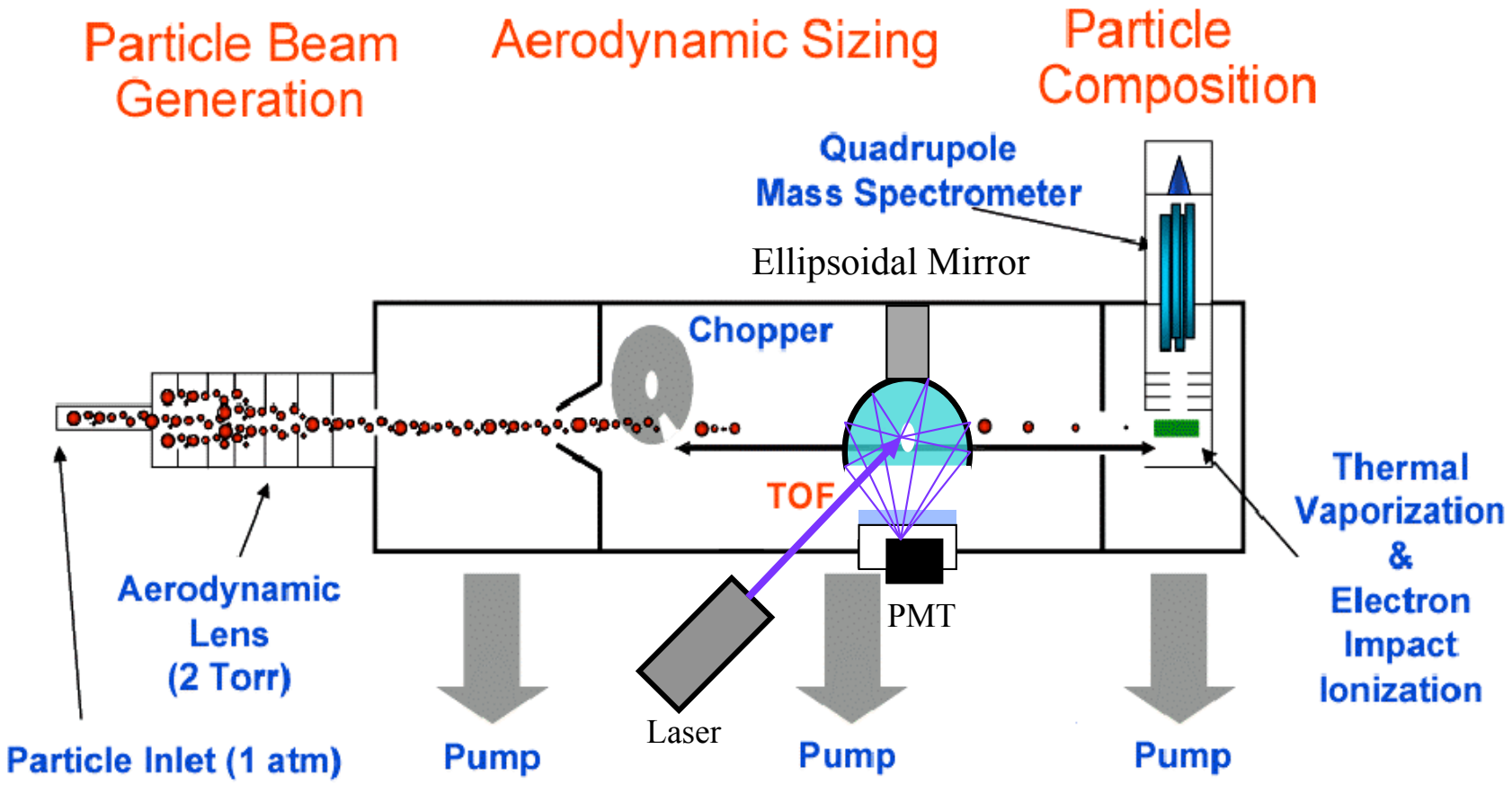
- $R_{LS} - d_p$ calibration curve allows the determination of an optical diameter (d_o). (Panel 3)
  - Using a single species calibration curve for spherical particles d_p is determined to +/- 10% accuracy across the refractive index range of $1.41 < n < 1.60$. (Panel 4)

- Combination of d_o and d_{va} provides a single particle density determination, $\rho_{LS} = (d_{va}/d_o)$.

- The LS-AMS per particle density determination allows the mixing state of the ambient aerosol particles to be analyzed.

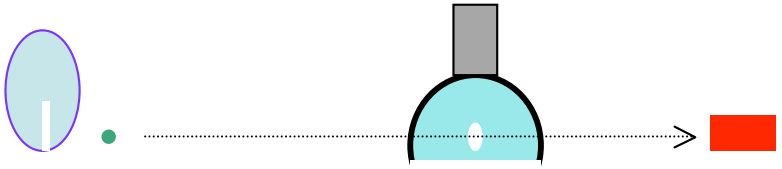
- Single particle density (ρ_{LS}) distributions obtained for ambient aerosol particles at Chebogue Point, Nova Scotia are highly correlated with the chemical composition-based density (ρ_{cc}) and show that the ambient particles are internal mixed. (Panel 6 and 7)

Schematic of the LS-AMS

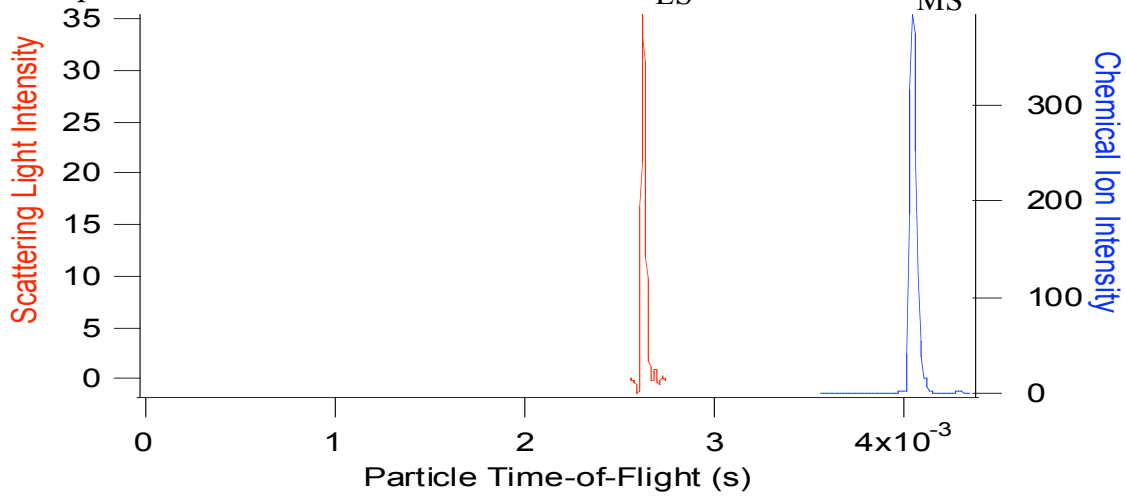


Correlated R_{LS} and R_{MS} Signals

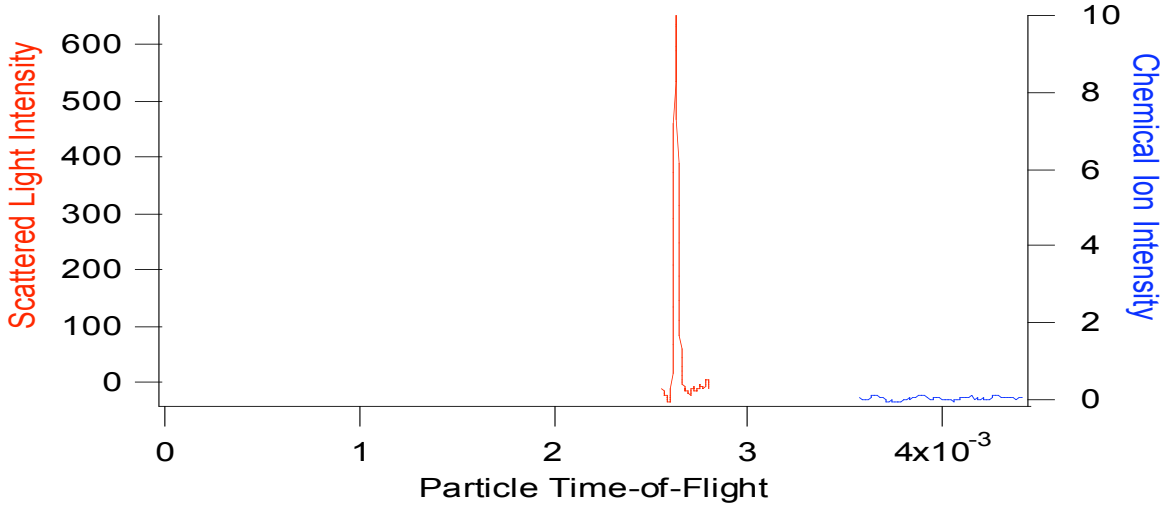
$$NH_4NO_{3\,(s)} \xrightarrow{600C} NH_{3(g)} + HNO_{3\,(g)} \xrightarrow{70eV\ e-} M^+ \text{ species}$$



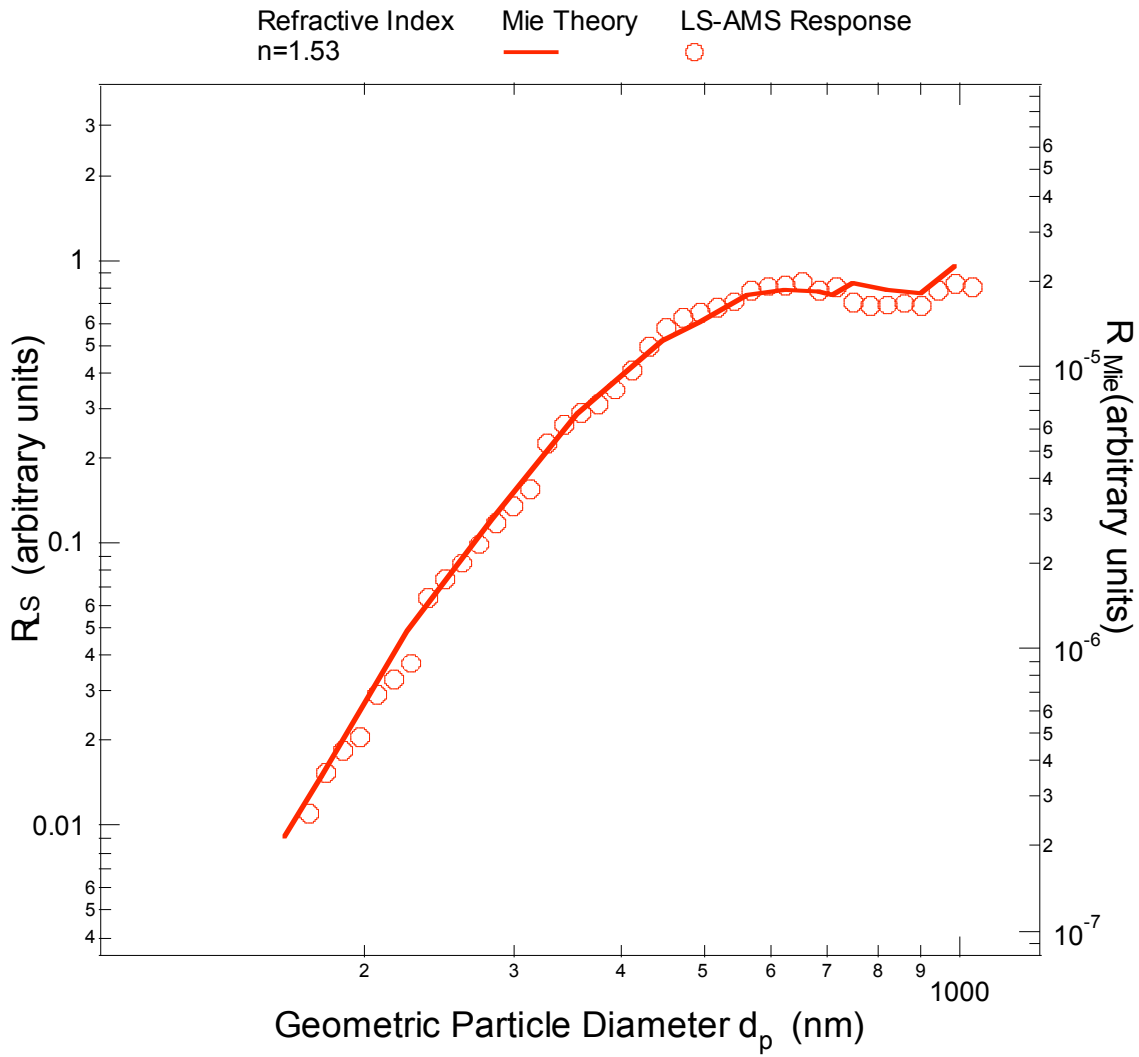
- Non-refractory aerosol particle
- **AND** chemically relevant quadrupole m/z setting



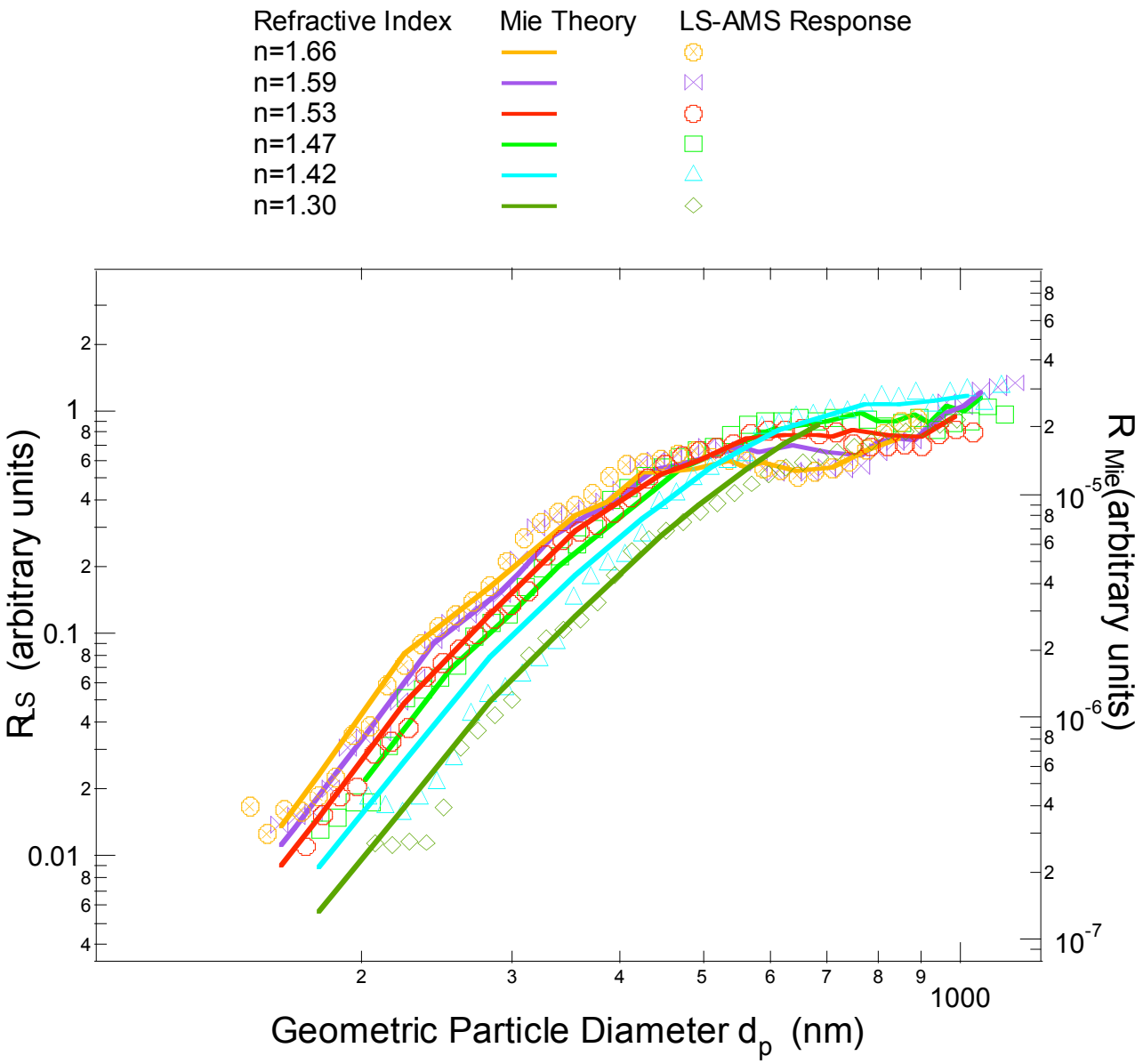
- Refractory aerosol particle
- Bounce
- **OR** uncorrelated quadrupole m/z setting



Experimental vs. Theoretical Scattering Response of the LS-AMS System



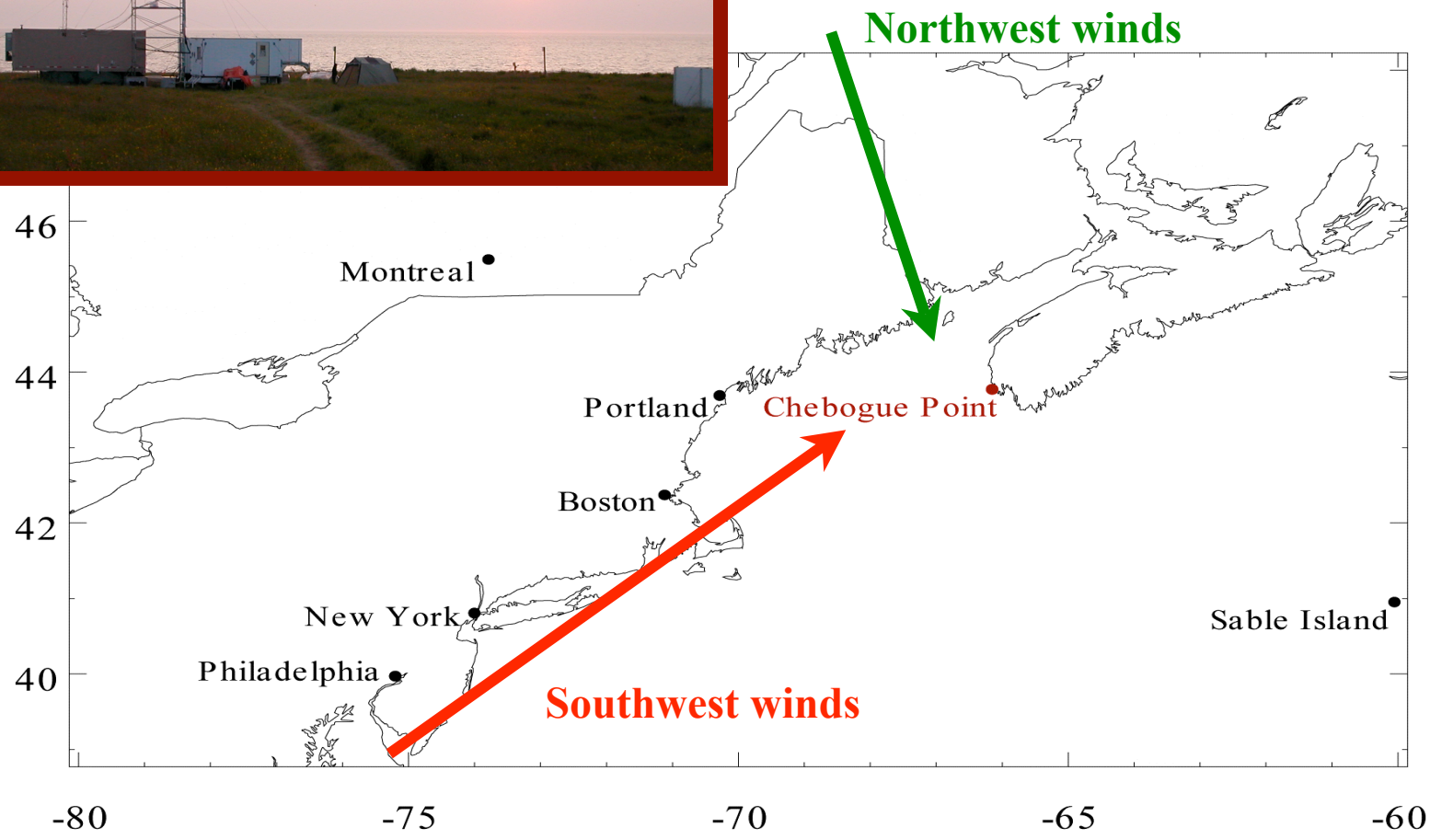
Effect of Refractive Index on R_{LS}



*Note: n = real component to complex refractive index. Absorption component for oil droplets (k ~ 0)

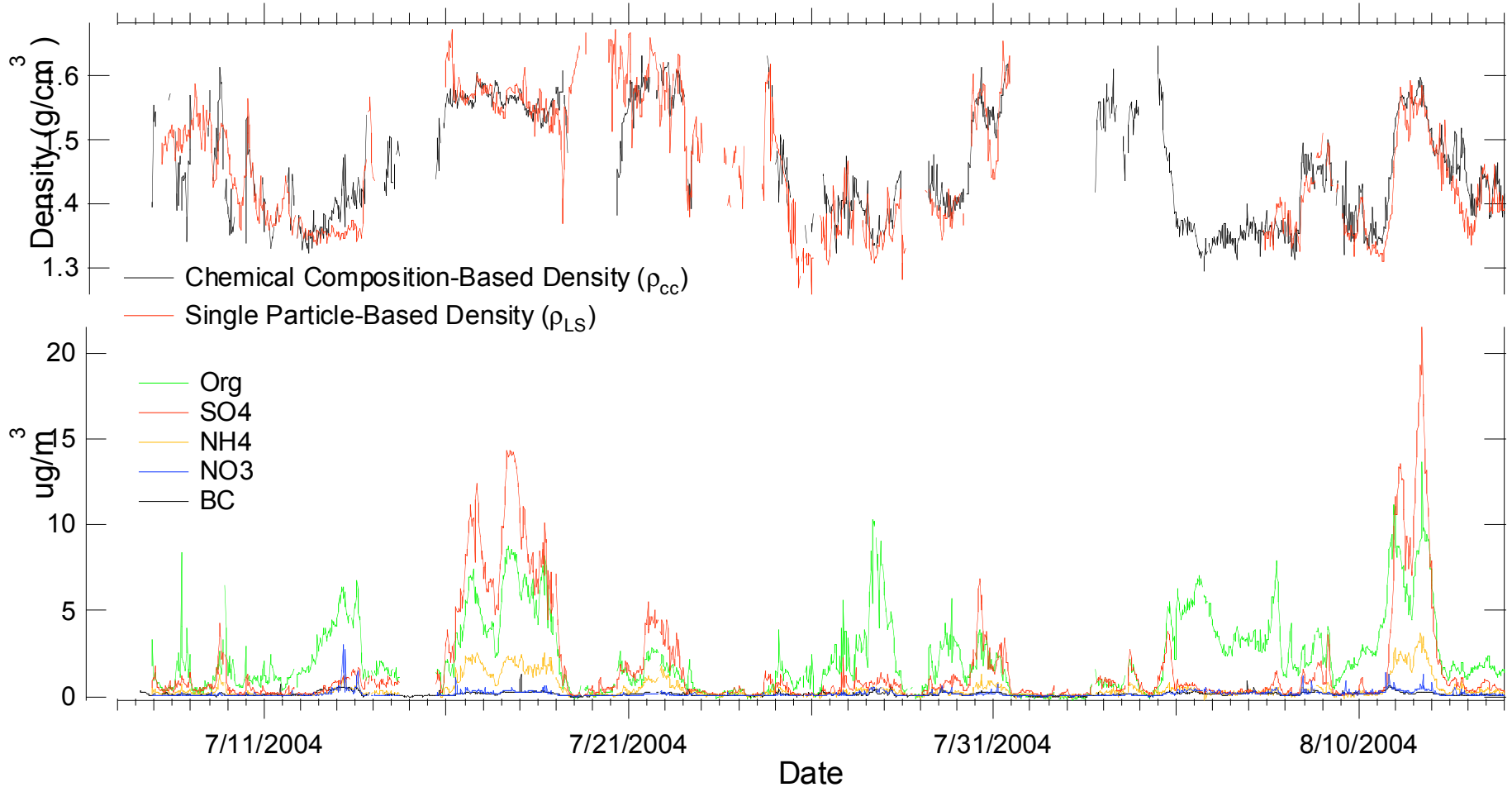
LS-AMS Deployment: Ambient Aerosol Analysis

July 11 – August 15, 2004
Chebogue Point, Nova Scotia



• Residence time of the aerosol particles in the atmosphere ~ days

Real-Time Determination of Chemical Composition, ρ_{cc} and ρ_{LS}



Correlation Between the two Density Measurements:

ρ_{cc} vs ρ_{LS}